CLAIMS

What is claimed is:

1. A method for planarizing a microelectronic workpiece, comprising:

removing material from a microelectronic workpiece during a first abrasive stage of a planarizing cycle by pressing the workpiece against a first planarizing surface having a first roughness and an abrasive slurry on the first planarizing surface; and

removing additional material from the workpiece during a second abrasive stage of the planarizing cycle by pressing the workpiece against a second planarizing surface having a second roughness and an abrasive slurry on the second planarizing surface, wherein the first roughness is greater than the second roughness.

2. The method of claim 1 wherein:

removing material from a microelectronic workpiece comprises providing a first plate and a first planarizing pad on the first plate, the first pad having a surface defining the first planarizing surface; and

removing additional material from the workpiece comprises providing a second plate and a second planarizing pad on the second plate, the second pad having a surface defining the second planarizing surface.

3. The method of claim 1 wherein:

removing material from a microelectronic workpiece comprises providing a first planarizing pad having a surface defining the first planarizing surface and conditioning the first planarizing surface to have the first roughness; and

removing additional material from the workpiece comprises providing a second planarizing pad having a surface defining the second

planarizing surface and conditioning the second surface to have the second roughness.

4. The method of claim 1 wherein:

pressing the workpiece against the first planarizing surface comprises pressing the workpiece against a planarizing surface of a first pad on a first plate; and

pressing the workpiece against the second planarizing surface comprises moving the workpiece away from the first pad and then pressing the workpiece against a planarizing surface of a second pad on a second plate.

5. The method of claim 1 wherein:

removing material from a microelectronic workpiece further comprises terminating the first abrasive stage when a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage and terminating the second abrasive stage at a desired endpoint.

6. The method of claim 1 wherein:

removing material from a microelectronic workpiece further comprises monitoring a drag force between the workpiece and the first planarizing surface and terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage, monitoring a drag force between the workpiece and the second

planarizing surface, and terminating the second abrasive stage when the drag force indicates that the workpiece is at a desired endpoint.

7. The method of claim 1 wherein removing material from a microelectronic workpiece further comprises:

monitoring a drag force between the workpiece and the first planarizing surface; and

terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer.

8. The method of claim 1, further comprising:

sensing a surface condition of the first planarizing surface; and

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed surface condition of the first planarizing surface.

9. The method of claim 1, further comprising:

sensing a surface condition of the first and second planarizing surfaces;

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed condition of the first planarizing surface; and

conditioning at least a portion of the second planarizing surface to have the second roughness according to the sensed condition of the second planarizing surface.

10. The method of claim 1, further comprising:

providing a single planarizing pad;

conditioning the single planarizing pad to have a planarizing surface with the first roughness to define the first planarizing surface for the first abrasive stage; and

reconditioning the planarizing surface of the single pad to have the second roughness to define the second planarizing surface for the second abrasive stage.

11. A method for planarizing a microelectronic workpiece, comprising:

removing material from a microelectronic workpiece during a first abrasive stage of a planarizing cycle by abrading the workpiece on a first planarizing surface having a first texture and an abrasive slurry on the first planarizing surface; and

removing additional material from the workpiece during a second abrasive stage of the planarizing cycle by abrading the workpiece on a second planarizing surface having a second texture and an abrasive slurry on the second planarizing surface, wherein the first texture removes material from a planar surface slower than the second texture.

12. The method of claim 11 wherein:

removing material from a microelectronic workpiece comprises providing a first plate and a first planarizing pad on the first plate, the first pad having a surface defining the first planarizing surface; and

removing additional material from the workpiece comprises providing a second plate and a second planarizing pad on the second plate, the second pad having a surface defining the second planarizing surface.

13. The method of claim 11 wherein:

removing material from a microelectronic workpiece comprises providing a first planarizing pad having a surface defining the first planarizing surface and conditioning the first planarizing surface to have the first texture; and

removing additional material from the workpiece comprises providing a second planarizing pad having a surface defining the second planarizing surface and conditioning the second surface to have the second texture.

14. The method of claim 11 wherein:

pressing the workpiece against the first planarizing surface comprises pressing the workpiece against a planarizing surface of a first pad on a first plate; and

pressing the workpiece against the second planarizing surface comprises moving the workpiece away from the first pad and then pressing the workpiece against a planarizing surface of a second pad on a second plate.

15. The method of claim 11 wherein:

removing material from a microelectronic workpiece further comprises terminating the first abrasive stage when a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage and terminating the second abrasive stage at a desired endpoint.

16. The method of claim 11 wherein:

removing material from a microelectronic workpiece further comprises monitoring a drag force between the workpiece and the first planarizing surface and terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage, monitoring a drag force between the workpiece and the second planarizing surface, and terminating the second abrasive stage when the drag force indicates that the workpiece is at a desired endpoint.

17. The method of claim 11 wherein removing material from a microelectronic workpiece further comprises:

monitoring a drag force between the workpiece and the first planarizing surface; and

terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer.

18. The method of claim 11, further comprising:

sensing a surface condition of the first planarizing surface; and

conditioning at least a portion of the first planarizing surface to have the first texture according to the sensed surface condition of the first planarizing surface.

19. The method of claim 11, further comprising:

sensing a surface condition of the first and second planarizing surfaces;

conditioning at least a portion of the first planarizing surface to have the first texture according to the sensed condition of the first planarizing surface; and

conditioning at least a portion of the second planarizing surface to have the second texture according to the sensed condition of the second planarizing surface.

20. The method of claim 11, further comprising:

providing a single planarizing pad;

conditioning the single planarizing pad to have a planarizing surface with the first texture to define the first planarizing surface for the first abrasive stage; and

reconditioning the planarizing surface of the single pad to have the second texture to define the second planarizing surface for the second abrasive stage.

21. A method for planarizing a microelectronic workpiece, comprising:

removing material from a microelectronic workpiece during a first abrasive stage of a planarizing cycle by pressing the workpiece against a first planarizing pad having a first roughness and an abrasive slurry on the first pad; and

removing additional material from the workpiece during a second abrasive stage of the planarizing cycle by pressing the workpiece against a second planarizing pad having a second roughness and an abrasive slurry on the second pad, wherein the first roughness is greater than the second roughness.

22. The method of claim 21, further comprising pressing the workpiece against a finishing pad coated with a non-abrasive solution after the second abrasive stage, wherein the finishing pad is separate from the first and second pads.

23. The method of claim 21 wherein:

removing material from a microelectronic workpiece further comprises terminating the first abrasive stage when a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage and terminating the second abrasive stage at a desired endpoint.

24. The method of claim 21 wherein:

removing material from a microelectronic workpiece further comprises monitoring a drag force between the workpiece and the first planarizing pad and terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage, monitoring a drag force between the workpiece and the second planarizing pad, and terminating the second abrasive stage when the drag force indicates that the workpiece is at a desired endpoint.

25. The method of claim 21 wherein removing material from a microelectronic workpiece further comprises:

monitoring a drag force between the workpiece and the first planarizing pad; and

terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer.

26. The method of claim 21, further comprising:

sensing a surface condition of the first planarizing pad; and

conditioning at least a portion of the first planarizing pad to have the first roughness by adjusting a downforce of a conditioning end-effector according to the sensed surface condition of the first planarizing pad.

27. The method of claim 21, further comprising:

sensing a surface condition of the first and second planarizing pads;

conditioning at least a portion of the first planarizing pad to have the first roughness according to the sensed condition of the first planarizing pad; and

conditioning at least a portion of the second planarizing pad to have the second roughness according to the sensed condition of the second planarizing pad.

28. A method of planarizing a microelectronic workpiece, comprising:

removing a first portion of a cover layer of material on a microelectronic workpiece during a first abrasive stage of a planarizing cycle by pressing the workpiece against a first planarizing surface having a first roughness and an abrasive slurry on the first planarizing surface, wherein an overburden portion of the cover layer of material is left remaining on the workpiece at the end of the first stage; and

removing the overburden portion of material from the cover layer on the workpiece during a second abrasive stage of the planarizing cycle by pressing the workpiece against a second planarizing surface having a second roughness and an abrasive slurry on the second planarizing surface, wherein the first roughness is greater than the second roughness.

29. The method of claim 28 wherein:

removing material from a microelectronic workpiece comprises providing a first plate and a first planarizing pad on the first plate, the first pad having a surface defining the first planarizing surface; and

removing additional material from the workpiece comprises providing a second plate and a second planarizing pad on the second plate, the second pad having a surface defining the second planarizing surface.

30. The method of claim 28 wherein:

removing material from a microelectronic workpiece comprises providing a first planarizing pad having a surface defining the first planarizing surface and conditioning the first planarizing surface to have the first roughness; and

removing additional material from the workpiece comprises providing a second planarizing pad having a surface defining the second planarizing surface and conditioning the second surface to have the second roughness.

31. The method of claim 28 wherein:

pressing the workpiece against the first planarizing surface comprises pressing the workpiece against a planarizing surface of a first pad on a first plate; and

pressing the workpiece against the second planarizing surface comprises moving the workpiece away from the first pad and then pressing the workpiece against a planarizing surface of a second pad on a second plate.

32. The method of claim 28 wherein:

removing material from a microelectronic workpiece further comprises terminating the first abrasive stage when the cover layer is at least substantially planar at an elevation in the overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage and terminating the second abrasive stage at a desired endpoint.

33. The method of claim 28 wherein:

removing material from a microelectronic workpiece further comprises monitoring a drag force between the workpiece and the first

planarizing surface and terminating the first abrasive stage when the drag force indicates that the cover layer is at least substantially planar at an elevation in the overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage, monitoring a drag force between the workpiece and the second planarizing surface, and terminating the second abrasive stage when the drag force indicates that the workpiece is at a desired endpoint.

34. The method of claim 28 wherein removing material from a microelectronic workpiece further comprises:

monitoring a drag force between the workpiece and the first planarizing surface; and

terminating the first abrasive stage when the drag force indicates that the cover layer is at least substantially planar at an elevation in the overburden portion of the cover layer.

35. The method of claim 28, further comprising:

sensing a surface condition of the first planarizing surface; and

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed surface condition of the first planarizing surface.

36. The method of claim 28, further comprising:

sensing a surface condition of the first and second planarizing surfaces;

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed condition of the first planarizing surface; and

conditioning at least a portion of the second planarizing surface to have the second roughness according to the sensed condition of the second planarizing surface.

37. A method of planarizing a microelectronic workpiece, comprising:

removing material from a microelectronic workpiece during a first abrasive stage of a planarizing cycle by pressing the workpiece against a first planarizing surface having a first roughness and an abrasive slurry on the first planarizing surface;

terminating the first abrasive stage of the planarizing cycle when the workpiece is at least approximately planar;

removing additional material from the workpiece during a second abrasive stage of the planarizing cycle by pressing the workpiece against a second planarizing surface having a second roughness and an abrasive slurry on the second planarizing surface, wherein the first roughness is greater than the second roughness; and

terminating the second abrasive stage of the planarizing cycle at a desired endpoint.

38. The method of claim 37 wherein:

removing material from a microelectronic workpiece comprises providing a first plate and a first planarizing pad on the first plate, the first pad having a surface defining the first planarizing surface; and

removing additional material from the workpiece comprises providing a second plate and a second planarizing pad on the second plate, the second pad having a surface defining the second planarizing surface.

39. The method of claim 37 wherein:

removing material from a microelectronic workpiece comprises providing a first planarizing pad having a surface defining the first planarizing

surface and conditioning the first planarizing surface to have the first roughness; and

removing additional material from the workpiece comprises providing a second planarizing pad having a surface defining the second planarizing surface and conditioning the second surface to have the second roughness.

40. The method of claim 39, further comprising pressing the workpiece against a finishing pad coated with a non-abrasive solution after the second abrasive stage, wherein the finishing pad is separate from the first and second pads.

41. The method of claim 37 wherein:

removing material from a microelectronic workpiece further comprises terminating the first abrasive stage when a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage and terminating the second abrasive stage at a desired endpoint.

42. The method of claim 37, further comprising:

sensing a surface condition of the first planarizing surface; and

conditioning at least a portion of the first planarizing surface to have the first roughness by adjusting a downforce of a conditioning end-effector according to the sensed surface condition of the first planarizing surface.

43. The method of claim 37, further comprising:

sensing a surface condition of the first and second planarizing surfaces;

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed condition of the first planarizing surface; and

conditioning at least a portion of the second planarizing surface to have the second roughness according to the sensed condition of the second planarizing surface.

44. A method of planarizing a microelectronic workpiece, comprising:

removing material from a microelectronic workpiece during a first abrasive stage of a planarizing cycle by pressing the workpiece against a first planarizing pad having a first roughness and an abrasive slurry on the first planarizing surface;

determining when the microelectronic workpiece is at least approximately planar;

removing additional material from the workpiece during a second abrasive stage of the planarizing cycle by pressing the workpiece against a second planarizing pad having a second roughness and an abrasive slurry on the second planarizing surface, wherein the first roughness is greater than the second roughness.

45. The method of claim 44 wherein:

determining planarity comprises monitoring a drag force between the workpiece and the first planarizing pad; and

the method further comprises terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer.

46. The method of claim 44, further comprising:

sensing a surface condition of the first planarizing pad; and

conditioning at least a portion of the first planarizing pad to have the first roughness according to the sensed surface condition of the first planarizing pad.

47. The method of claim 44, further comprising:

sensing a surface condition of the first and second planarizing pad;

conditioning at least a portion of the first planarizing pad to have the first roughness according to the sensed condition of the first planarizing pad; and

conditioning at least a portion of the second planarizing pad to have the second roughness according to the sensed condition of the second planarizing pad.

48. A method of planarizing a microelectronic workpiece, comprising:

reducing topographical variances across a surface of a microelectronic workpiece during a first abrasive stage of a planarizing cycle by abrading the workpiece against a surface having a first roughness;

terminating the first abrasive stage of the planarizing cycle at an overburden level in a layer of material on the workpiece before the desired endpoint; and

removing additional material from a planar surface on the workpiece during a second abrasive stage of the planarizing cycle by abrading the workpiece against a second planarizing surface having a second roughness less than the first roughness.

49. A method of planarizing a microelectronic workpiece, comprising:

conditioning a first planarizing surface to have a first roughness;

removing material from a microelectronic workpiece during a first abrasive stage of a planarizing cycle by pressing the workpiece against the first planarizing surface having the first roughness and an abrasive slurry on the first planarizing surface;

conditioning a second planarizing surface to have a second roughness less than the first roughness; and

removing additional material from the workpiece during a second abrasive stage of the planarizing cycle by pressing the workpiece against the second planarizing surface having the second roughness and an abrasive slurry on the second planarizing surface.

50. The method of claim 49 wherein:

removing material from a microelectronic workpiece comprises providing a first plate and a first planarizing pad on the first plate, the first pad having a surface defining the first planarizing surface; and

removing additional material from the workpiece comprises providing a second plate and a second planarizing pad on the second plate, the second pad having a surface defining the second planarizing surface.

51. The method of claim 49 wherein:

removing material from a microelectronic workpiece comprises providing a first planarizing pad having a surface defining the first planarizing surface and conditioning the first planarizing surface to have the first roughness; and

removing additional material from the workpiece comprises providing a second planarizing pad having a surface defining the second planarizing surface and conditioning the second surface to have the second roughness.

52. The method of claim 49 wherein:

pressing the workpiece against the first planarizing surface comprises pressing the workpiece against a planarizing surface of a first pad on a first plate; and

pressing the workpiece against the second planarizing surface comprises moving the workpiece away from the first pad and then pressing the workpiece against a planarizing surface of a second pad on a second plate.

53. The method of claim 49 wherein:

removing material from a microelectronic workpiece further comprises terminating the first abrasive stage when a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage and terminating the second abrasive stage at a desired endpoint.

54. The method of claim 49 wherein:

removing material from a microelectronic workpiece further comprises monitoring a drag force between the workpiece and the first planarizing surface and terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer; and

removing additional material from the workpiece comprises commencing the second abrasive stage after terminating the first abrasive stage, monitoring a drag force between the workpiece and the second planarizing surface, and terminating the second abrasive stage when the drag force indicates that the workpiece is at a desired endpoint.

55. The method of claim 49 wherein removing material from a microelectronic workpiece further comprises:

monitoring a drag force between the workpiece and the first planarizing surface; and

terminating the first abrasive stage when the drag force indicates that a cover layer on a face of the workpiece is at least substantially planar at an elevation in an overburden portion of the cover layer.

56. The method of claim 49, further comprising:

sensing a surface condition of the first planarizing surface; and

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed surface condition of the first planarizing surface.

57. The method of claim 49, further comprising:

sensing a surface condition of the first and second planarizing surfaces;

conditioning at least a portion of the first planarizing surface to have the first roughness according to the sensed condition of the first planarizing surface; and

conditioning at least a portion of the second planarizing surface to have the second roughness according to the sensed condition of the second planarizing surface.

58. A method of conditioning a planarizing pad used in planarization of microelectronic workpieces, comprising:

providing a first roughness on a planarizing surface of a first planarizing pad on a first support plate of a planarizing machine; and

providing a second roughness on a planarizing surface of a second planarizing pad on a second support plate of the planarizing machine.

59. A planarizing machine for planarization of microelectronic workpieces, comprising:

a first support plate;

a first planarizing medium having a first pad on the first support plate and an abrasive slurry on the first pad, wherein the first pad has a first surface with a first roughness;

a second support plate;

a second planarizing medium having a second pad on the second support plate and an abrasive slurry on the second pad, wherein the second pad has a second surface with a second roughness; and

a workpiece carrier assembly having a workpiece holder to move the workpiece relative to the first planarizing medium and the second planarizing medium.

60. A planarizing machine for planarization of microelectronic workpieces, comprising:

a first support plate;

a first planarizing medium having a first pad on the first support plate and an abrasive slurry on the first pad, wherein the first pad has a first surface with a first roughness;

a second support plate;

a second planarizing medium having a second pad on the second support plate and an abrasive slurry on the second pad, wherein the second pad has a second surface with a second roughness;

a workpiece carrier assembly having a workpiece holder to move the workpiece relative to the first planarizing medium and the second planarizing medium; and

a computer operatively coupled to the first support plate, the second support plate and the workpiece carrier assembly, the computer including a computer readable medium containing instructions to cause the workpiece carrier to press the workpiece against the first

planarizing pad during a first abrasive stage of a planarizing cycle, move the workpiece from the first planarizing pad to the second planarizing pad at the end of the first abrasive stage, and press the workpiece against the second planarizing pad during a second abrasive stage of the planarizing cycle.

61. A planarizing machine for planarization of microelectronic workpieces, comprising:

a first support plate;

a first planarizing medium having a first pad on the first support plate and an abrasive slurry on the first pad, wherein the first pad has a first surface with a first roughness;

a second support plate;

a second planarizing medium having a second pad on the second support plate and an abrasive slurry on the second pad, wherein the second pad has a second surface with a second roughness;

a workpiece carrier assembly having a workpiece holder to move the workpiece relative to the first planarizing medium and the second planarizing medium; and

a monitoring system for determining when the workpiece has become planar.